Biological Evaluation

of 2015 Gypsy Moth Populations

At Raystown Lake

Prepared by

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ABSTRACT

In the fall of 2015, personnel from US Army Corps of Engineers (ACOE) conducted gypsy moth egg mass surveys at Raystown Lake to assess the potential for defoliation and the need for treatment in 2016. Current populations are sufficient to cause noticeable defoliation on approximately 8,500 acres. Treatment is recommended in these areas for 2016.

INTRODUCTION

During the summer of 2015, aerial and ground surveys performed by Pennsylvania Department of Conservation and Natural Resources (PA-DCNR) identified 700,315 acres of forest defoliated by the gypsy moth statewide. This is a dramatic increase from the 213,415 acres mapped in 2014. No noticeable defoliation was recorded at Raystown Lake in 2014 and 2015 but resources managers from both ACOE and PA-DCNR noticed the presence of caterpillars and a large number of egg masses being laid by females in the late summer. Quick visual surveys of the area triggered a need for a more thorough gypsy moth survey across the Raystown Lake Project area.

The gypsy moth, *Lymantria dispar* (Linneaus) is a non-native defoliator of forest, shade and ornamental trees throughout the Northeastern United States. Since its intentional importation and accidental release in eastern Massachusetts in 1869, the gypsy moth has steadily expanded its range. Despite many attempts to halt its spread westward from the northeastern United States, Pennsylvania experienced its first gypsy moth defoliation in 1968. Since that time, the gypsy moth has defoliated nearly 28 million acres in the state.

The gypsy moth produces one generation per year. Larvae begin hatching from egg masses in late April and early May when tree buds begin to open. At this time, larvae go through an obligatory dispersal period where they leave the vicinity of the egg, moving upward and spinning a thread of silk as they go (Leonard 1981). Eventually the wind catches the larvae and disperses them. Airborne larvae are carried and deposited some distance downwind from the source with the following results: 1) larvae will land on or crawl onto acceptable host plants and begin feeding; 2) larvae will land on either acceptable or unacceptable host plants and re-disperse; 3) larvae will be deposited into areas unacceptable for survival and re-dispersal where they will die (Mason and McManus 1981). The larvae feed for two to three months completing their development by late June and early July and seek sheltered areas in which to pupate. The pupal period last anywhere from 10 days to two weeks. After emerging from the pupal case the females, which cannot fly, crawl a short distance and emit a pheromone scent to attract males. After mating, the female lays a single egg mass that contains from 75 to 1,000 eggs, which she covers with hairs from her abdomen giving it a fuzzy brown texture and color. The egg masses over winter and hatch the following spring.

The number of host trees and shrubs fed on by the gypsy moth exceeds 300 species, with species of oaks (*Quercus* spp.) ranked among the most favored (Leonard 1981). Gypsy moth is an outbreak species whose populations can remain at low levels for several years, then undergo large population increases in a matter of one or two years. After populations have increased to an outbreak density they can remain high for one to five years, outbreaks decline suddenly to low densities where it is difficult to find any life stage (Liebhold et al. 2000). The main effects of gypsy moth feeding on individual trees involves the depletion of root carbohydrate food resources leading to a reduction in growth, reproduction, and increased vulnerability to secondary agents of mortality. Heavy defoliation forces re-foliation which occurs when about 60 percent of the foliage is lost (Liebhold et al. 1994). This re-foliation uses carbohydrate reserves in trees and can increase their vulnerability to drought and to other insects and diseases. This defoliation and subsequent tree mortality can alter wildlife habitats, change water quality and temperature, increase forest floor temperatures and light levels and reduces aesthetic, recreational, and property values of forests and urban environments.

mast production

METHODS

Surveys were conducted in 25 areas by personnel from ACOE. Within each area, gypsy moth survey plots were randomly established based upon available host trees (oak species), size of survey area, and uniformity between egg mass counts. At each survey plot, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all new egg masses observed on the overstory trees and understory vegetation. The total number of egg masses observed for each survey plot was multiplied by 40 to determine the number of egg masses per acre.

RESULTS

The location of survey plots and survey results are located in Appendix A. Overall egg mass densities ranged from 0-5,320 egg masses/acre. Survey results from the northern half of the Raystown Lake Project were the highest. Additional gypsy moth survey plots within the northern area were established by PA-DCNR because of adjacent state owned lands. Their results showed infestation levels ranging from 500-7,000 egg masses per acre.

DISCUSSION

The greatest potential for heavy defoliation (>60%) in 2016 exists within those survey areas where the egg mass counts exceed the 1,000-egg masses/acre threshold. Defoliation of this intensity could lead to permanent tree damage (crown decline, dieback and mortality). The potential for "moderate" defoliation (30-60%) in 2016 exists within those areas where the egg mass counts are between 500–1,000 egg masses/acre (Liebhold 1994). Defoliation at this level creates nuisance larval densities and moderate defoliation that can adversely effect tree growth and have an impact on recreation and view-sheds.

Predicting the extent of impact of gypsy moth on individual trees or areas is uncertain. In cases in which two or more consecutive years of defoliation have occurred, some level of prediction can be made based on changes in egg mass density, size, and presence of control factors (i.e. predators, parasites and diseases). Gypsy moth population trends (density and egg mass length) in the surveyed areas are increasing because no noticeable gypsy moth defoliation or life stages were present at the site prior to 2015. If these areas are not treated, studies have shown (Gottschalk 1989), that reduced growth, mast abortion, branch dieback or in some cases tree mortality, has been observed following a single year of heavy defoliation. Should a subsequent period of drought or other stressors occur during a defoliation event or even after, the potential impact on individual trees may be compounded.

The natural control factors operating in the surveyed areas were not quantitatively surveyed, but field personnel noted the presence of dead and dying caterpillars due to the gypsy moth fungus, *Entomophaga maimaiga* and gypsy moth nucleopolyhedrosis virus (NPV). The fungus is known to be present wherever gypsy moth is distributed in Pennsylvania and has influenced the successful reduction of gypsy moth infestations across the state in previous years.

Proposed treatment blocks were configured based on populations greater than 500 egg masses/ acre, areas that are managed for recreation and timber (oak), and areas bordering cooperating landowners (PA-DCNR and PA State Game lands) that are also managing for gypsy moth. Raystown is proposing to treat 11 spray blocks totaling 8,224 acres (Appendix B).

GYPSY MOTH MANAGEMENT OPTIONS

For 2016, two management options have been evaluated for managing gypsy moth populations at Raystown Lake. The intervention option is offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each option is discussed below.

NO ACTION OPTION

It is possible that gypsy moth populations could collapse due to the presence of NPV or the gypsy moth fungus. Even though the fungus is present in all counties of Pennsylvania, the impact of the disease cannot be predicted being influenced primarily by environmental conditions during the spring and summer months. Where defoliating gypsy moth populations are greater than 500 egg masses/acre, viral epizootics generally manifest themselves only after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in one to five years once they reach defoliating levels and then collapse because of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for several

years before rebuilding to defoliating levels. Although it is difficult to accurately assess the sequence of such events, it is unlikely that a collapse will occur since these areas are in the first year of infestation and there is an abundance of large egg masses.

Should this option be selected, it is likely that defoliation will occur and population densities will increase in newly infested stands and expand to currently uninfested areas.

MICROBIAL INSECTICIDE OPTIONS

The second option is to use a microbial insecticide to manage gypsy moth populations. The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide, *Bacillus thuringiensis* variety *kurstaki (Btk)*. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis, which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* has been shown to impact other non-target caterpillars that are exposed to the treatment and are actively feeding. *Btk* is persistent on foliage for about 7-10 days.

Btk formulations are available as a flowable concentrate. The normal application rates range from 24-38 cabbage looper units (CLUs) per acre in a single application for a total volume of ½ to ¾ gallon per acre. Double applications maybe used in areas of healthy building populations where the egg mass densities may exceed 3,000 egg masses per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely. Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

A second microbial insecticide that is registered and available in limited quantities is the formulated gypsy moth nucleopolyhedrosis virus called Gypchek® (U.S. Forest Service, USDA, Washington, DC). This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymantriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities because of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year. The normal application rate of Gypchek is 2 $x10^{11}$ occlusion bodies (OB's) per acre applied once. Due to its limited availability, Gypchek is only applied in environmentally sensitive areas (i.e. known T&E species of Lepidoptera).

With the previously described options in mind, the following alternatives are offered.

Alternative 1. -No action

Alternative 2 A double aerial application of *Btk* at the rate of 38 CLU/ac (5-7 days apart) is recommended for areas that exceed 3,000 egg masses/acre. But due to application costs and logistics, one aerial application of *Btk* at the rate of 38 CLU/acre is proposed for all proposed treatment areas.

RECOMMENDATIONS

As previously stated, gypsy moth populations at Raystown Lake are sufficient to cause widespread moderate and heavy defoliation in 2016. In order to protect tree foliage, mast production and prevent subsequent tree mortality, the recommendation is to implement Alternative 2 (a single application of *Btk*) on 8,224 acres.

REFERENCES

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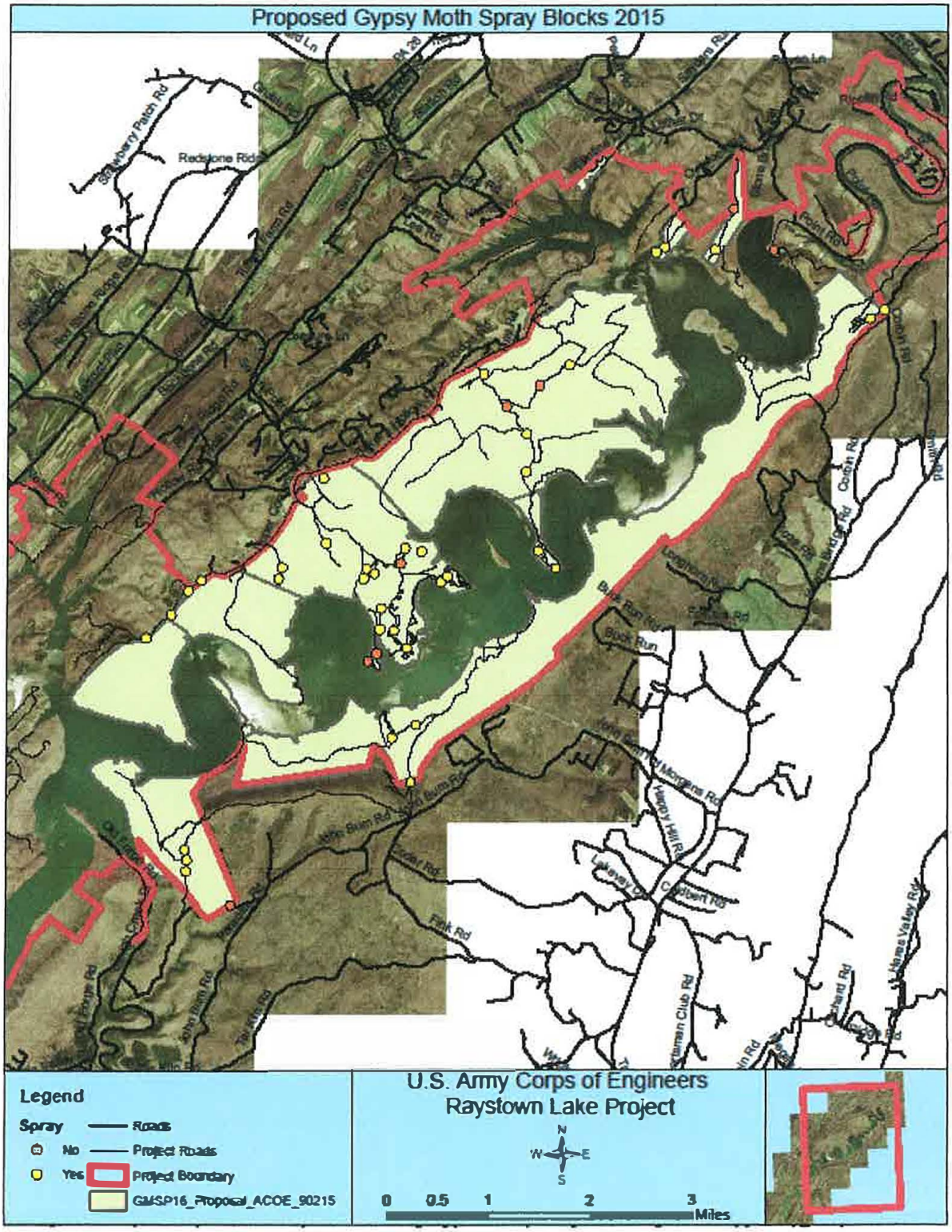
APPENDIX A

Gypsy Moth Survey Results
Gypsy Moth Survey Map

APPENDIX B

2016 Proposed Treatment Blocks

Spray Block	Acres
1	499
2	576
3	1,280
4	2,507
5	35
6	76
7	31
8	49
9	94
10	2,431
11	646
Total:	**8,224**


Proposed Gypsy Moth Spray Blocks 2015
Redstone Rd
Point Rd
Beaver Run Rd
Buck Run
Happy Hill Rd
Cedar Rd
Fink Rd
Legend
Spray
No
Yes
Roads
Project Roads
Project Boundary
GMSP16_Proposal_ACOE_90215
U.S. Army Corps of Engineers
Raystown Lake Project
N
W
E
S
0 0.5 1 2 3
Miles